



September 28, 2011

Ms. Vera Fischer  
California Regional Water Quality Control Board  
Central Valley Region  
11020 Sun Center Drive #200  
Rancho Cordova, CA 95670-6114

**Subject:** *Indoor Air Risk Assessment for  
City of Sacramento Colfax Maintenance Yard  
Colfax Street and Arden Way, Sacramento, California  
Project Number 11-1571-01*

Dear Ms. Fischer,

The City of Sacramento, Department of General Services (City) contracted with The Westmark Group (Westmark) to complete a site specific indoor air human health risk assessment for residential and commercial receptors at the Colfax Maintenance Yard (Site) using a Johnson and Ettinger or equivalent screening model and data presented in an October 29, 2010 ENGEO Inc., Soil Vapor and Groundwater Assessment report for the Site (ENGEO Report). The need for the assessment was identified in a July 21, 2011 letter to the City from the California Regional Water Quality Control Board, Central Valley Region (Water Board). The chemicals of concern (COC) are benzene, trichloroethylene (TCE), and tetrachloroethylene (PCE) and the media of concern (MOC) are shallow and deep soil vapor and groundwater. Both the maximum concentration detected and the 95% upper confidence concentrations for the COC were evaluated. The screening criteria for residential and commercial receptors were 1.0E-06 for cancer risk and 1.0 for the non-cancer hazard quotient.

## SUMMARY

The screening revealed that for residential and commercial receptors for all COC and MOC the non-cancer hazard quotients were less than 1.0. The cancer risk screening of the COC indicated that residential development of the Site would not be recommended because in-door air vapor intrusion exceeds the screening criteria. Commercial development of the Site is feasible.

## SCREENING MODELS AND MODEL INPUT

**Screening Models.** The U.S. EPA Johnson & Ettinger Models, as modified by California Cal/EPA, were used to evaluate subsurface vapor intrusion into buildings from soil gas and groundwater. In general the models default criteria for the COC were used. Site specific values for the MOC were used and are described in the following subsections. The models are available at [www.dtsc.ca.gov/Assessing\\_Risk/JE\\_Models.cfm](http://www.dtsc.ca.gov/Assessing_Risk/JE_Models.cfm).

**COC Concentrations.** For each COC, the maximum detected concentrations for each MOC were obtained from Table 1 for soil vapor concentrations and Table 2 for groundwater concentrations from the ENGEO Report. In the cases where the modeling of a maximum COC

concentration was greater than the screening criteria, the 95% upper confidence concentrations were calculated and modeled. The data inputs and results for the 95% concentration calculations, where appropriate, are presented in Attachments A-C for benzene, TCE and PCE, respectively. The model input concentrations were:

### **Benzene**

Soil gas shallow (8-10 ft):

Maximum concentration = 630 µg/m<sup>3</sup>  
95% confidence concentration = 280 µg/m<sup>3</sup> (Table A1)

Soil gas deep (23-25 ft):

Maximum concentration = 290 µg/m<sup>3</sup>

Groundwater:

Maximum concentration = 1.3 µg/l

### **Trichloroethylene**

Soil gas shallow (8-10 ft):

Maximum concentration = 2,900 µg/m<sup>3</sup>

Soil gas deep (23-25 ft):

Maximum concentration = 73,000 µg/m<sup>3</sup>  
95% confidence concentration = 14,000 µg/m<sup>3</sup> (Table B1)

Groundwater:

Maximum concentration = 4,600 µg/l

95% confidence concentration = 1,900 µg/l (Table B2)

### **Tetrachloroethylene**

Soil gas shallow (8-10 ft):

Maximum concentration = 300 µg/m<sup>3</sup>

Soil gas deep (23-25 ft):

Maximum concentration = 2,400 µg/m<sup>3</sup>

Groundwater:

Maximum concentration = 120 µg/l

95% confidence concentration = 64 µg/l (Table C1)

**Soil Lithology.** The ENGEO Report states that a cone penetrometer (CPT) was used to log the site geology and found "interbedded layers of silt/clay and very dense sand within the first 32 feet below ground surface (bgs), and an increased sand content from 32 to 50 feet bgs." No CPT log was included in the ENGEO Report. A Westmark geologist reviewed the boring logs from the installation in 1994 of five monitoring wells at the Site. The geologist concluded from these logs that an SCS soil type designation of silt (SI) best described the soil lithology of the Site and therefore SI was used for the soil type in the screening modeling.

**Soil and Groundwater Temperatures.** The ENGEO Report sampling log for MW3 reported a groundwater temperature of approximately 19°C. This temperature was used in the groundwater modeling. The "Users Guide for Evaluating Subsurface Intrusion into Buildings" (US EPA, March 2003) states "Shallow groundwater temperatures may be used to approximate subsurface soil temperature greater than 1 to 2 meters below the ground surface." Since the soil gas sampling depths reported in the ENGEO Report exceeded two (2) meters, 19°C was used for the soil gas modeling temperature.

**Exposure Duration and Frequency.** US EPA and State default values for exposure duration and frequency were used in the modeling. These were:

Averaging Time for carcinogens, residential and commercial: 70 years  
Averaging Time for non-carcinogens, residential: 30 years  
Averaging Time for non-carcinogens, commercial: 25 years  
Exposure Duration residential: 30 years  
Exposure Frequency residential: 350 days/year  
Exposure Duration commercial: 25 years  
Exposure Frequency commercial: 250 days/year, 10 hours/day on Site = 105 days/year

## SCREENING MODEL RESULTS AND CONCLUSION

The human health risk screening model outputs are summarized in Table 1, and included in Attachments A, B, and C for benzene, TCE, and PCE, respectively. For benzene, the cancer risk screening of the maximum concentrations reported or the 95% upper confidence concentration (shallow soil gas) for each MOC were less than 1.0E-06 screening criteria, so for benzene residential or commercial land use would be acceptable. For TCE, the cancer risk screening for shallow soil gas using the maximum concentration reported was less than the 1.0E-06 screening criteria. For deep soil gas and groundwater the residential land use screening using the maximum concentrations reported or the 95% upper confidence concentration exceeded the 1.0E-06 screening criteria, but was less than the screening criteria for commercial land use. For PCE, the cancer risk screening for shallow and deep soil gas using the maximum concentration reported was less than the 1.0E-06 screening criteria. For groundwater the residential land use screening using the maximum concentrations reported or the 95% upper confidence concentration exceeded the 1.0E-06 screening criteria, but was less than the screening criteria for commercial land use.

The screening revealed that for residential and commercial receptors for all COC and MOC the non-cancer hazard quotients were less than 1.0. These results were not unexpected because the COC were volatile organic compounds and hazard is more associated with inorganic or metals contamination.

In conclusion, the human health risk screening for the Colfax Maintenance Yard COC and MOC revealed that for residential development the risk screening criteria is exceeded, however for commercial development the risk screening criteria is not exceeded.

Westmark is pleased to assist the City in this endeavor. Please feel free to contact Karl Kurka or Rob Kull at (530) 672-4017 if you wish to discuss any aspect of this report.

Sincerely,  
The Westmark Group Inc.



Michael Clegg, P.E.  
Project Engineer



Robert N. Kull, P.E.  
Vice President of Operations



cc: Mr. Karl Kurka, City of Sacramento

Attachments:

- A Benzene Soil Vapor and Groundwater Risk and Hazard Screening and Benzene 95% Upper Confidence Concentration Determination
- B TCE Soil Vapor and Groundwater Risk and Hazard Screening and TCE 95% Upper Confidence Concentrations Determination
- C PCE Soil Vapor and Groundwater Risk and Hazard Screening and PCE 95% Upper Confidence Concentration Determination

**Table 1. HUMAN HEALTH RISK SCREENING RESULTS  
USING JOHNSON & ETTINGER MODELS**

ACCEPTANCE CRITERIA: CANCER RISK 1.0E-06  
(LESS THAN OR EQUAL TO) NON-CANCER HAZARD 1.0

CHEMICAL OF CONCERN (COC) & CONCENTRATION SCREENED (1)	MEDIA Of CONCERN (MOC)	SCREENING RESULT		ACCEPTABLE LAND USE (YES/NO)	
		RISK	HAZARD	RESIDENTIAL	COMMERCIAL
<b>Benzene</b>					
Max Conc = 630 ug/M3	Soil Gas Shallow	1.6E-06	4.4E-03	No	
Max Conc = 630 ug/M3	Soil Gas Shallow	4.1E-07	1.3E-03	Yes	Yes
95% Conc = 280 ug/M3	Soil Gas Shallow	7.5E-07	2.0E-03	Yes	Yes
Max Conc = 290 ug/M3	Soil Gas Deep	5.3E-07	1.4E-03	Yes	Yes
Max Conc = 1.3 ug/l	Groundwater	8.3E-08	2.2E-04	Yes	Yes
<b>Trichloroethylene (TCE)</b>					
Max Conc = 2,900 ug/M3	Soil Gas Shallow	5.3E-07	1.0E-03	Yes	Yes
Max Conc = 73,000 ug/M3	Soil Gas Deep	8.4E-06	1.6E-02	No	
95% Conc = 14,000 ug/M3	Soil Gas Deep	1.6E-06	3.2E-03	No	
Max Conc = 73,000 ug/M3	Soil Gas Deep	2.1E-06	4.9E-03		No
95% Conc = 14,000 ug/M3	Soil Gas Deep	4.3E-07	1.0E-03		Yes
Max Conc = 4,600 ug/l	Groundwater	3.3E-05	6.4E-02	No	
95% Conc = 1,900 ug/l	Groundwater	1.3E-05	2.6E-02	No	
Max Conc = 4,600 ug/l	Groundwater	8.2E-06	1.9E-02		No
95% Conc = 1,900 ug/l	Groundwater	9.8E-07	2.3E-03		Yes
<b>Tetrachloroethylene (PCE)</b>					
Max Conc = 300 ug/M3	Soil Gas Shallow	1.4E-07	1.6E-03	Yes	Yes
Max Conc = 2,400 ug/M3	Soil Gas Deep	7.7E-07	8.7E-03	Yes	Yes
Max Conc = 120 ug/l	Groundwater	4.0E-06	4.5E-02	No	
95% Conc = 64 ug/l	Groundwater	2.1E-06	2.3E-02	No	
Max Conc = 120 ug/l	Groundwater	1.0E-06	1.4E-02		Yes

- (1) Maximum concentrations from ENGEO "Colfax Maintenance Yard Soil Vapor and Groundwater Assessment" October 2010  
95% confidence concentration calculated using ENGEO data and EXCEL data analysis package

## **ATTACHMENT A**

BENZENE SOIL VAPOR AND GROUNDWATER RISK AND HAZARD  
SCREENING BENZENE 95% UPPER CONFIDENCE CONCENTRATION  
DETERMINATION

SG-SCREEN  
PA Version 2.0.04/

Reset to  
Defaults

DATA ENTRY SHEET

DTSC

Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Sed - one soil - S Currell  
max conc 630 ug/m<sup>3</sup> SV 14-16  
com enclos [ ] (105 days/yr)

Soil Gas Concentration Data				
ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )  71432	OR  6.30E+02	ENTER Soil gas conc., $C_g$ (ppmv)  Benzene	Chemical

Soil Gas Sampling Data							
ENTER Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)	ENTER Soil gas sampling depth below grade, $L_s$ (cm)  15	ENTER Average soil temperature, $T_s$ (°C)  310	ENTER Vadose zone SCS soil type  SI	ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^3$ )  19	ENTER User-defined vadose zone soil type (used to estimate soil vapor permeability)  SI	ENTER User-defined vadose zone soil water-filled porosity, $\theta_w$ ( $\text{cm}^3/\text{cm}^3$ )  0.43	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{\text{soil}}$ ( $\text{L}/\text{m}$ )  0.15

Soil Properties				
ENTER Vadose zone SCS soil type  MORE ↓ Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g}/\text{cm}^3$ )  SI	ENTER Vadose zone soil total porosity, $\eta^V$ (unitless)  1.5	ENTER Vadose zone soil water-filled porosity, $\theta_w$ ( $\text{cm}^3/\text{cm}^3$ )  0.43	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{\text{soil}}$ ( $\text{L}/\text{m}$ )  0.15

Exposure Parameters				
ENTER Averaging time for carcinogens, $A T_c$ (yrs)  MORE ↓	ENTER Averaging time for noncarcinogens, $A T_{NC}$ (yrs)  70	ENTER Exposure duration, $ED$ (yrs)  25	ENTER Exposure frequency, $EF$ (days/yr)  25	ENTER Exposure frequency, $EF$ (days/yr)  105

END

Benzene Soil Gas Shallow  
max conc 630  $\mu\text{g}/\text{m}^3$  SV 14-1C  
Commercial (105 days/yr)

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.1E-07	1.3E-03

MESSAGE SUMMARY BELOW:

**TABLE A1. BENZENE SHALLOW SOIL GAS  
95% CONFIDENCE CONCENTRATION DETERMINATION**

Sample ID	Sample Depth (ft)	Benzene Concentration (ug/M3)	<i>EXCEL Statistic Analysis</i>	
SV1-8	8	410		
SV2-8	8	100	Mean	224.2105263
SV3-10	10	140	Standard Error	29.88590183
SV4-8	8	100	Median	200
SV5-8	8	150	Mode	100
SV6-8	8	150	Standard Deviation	130.2696259
SV7-8	8	260	Sample Variance	16970.17544
SV8-10	10	100	Kurtosis	4.429228944
SV9-10	10	220	Skewness	1.911367539
SV10-8	8	230	Range	530
SV11-8	8	270	Minimum	100
SV12-8	8	250	Maximum	630
SV13-10	10	160	Sum	4260
SV14-10	10	630	Count	19
SV15-10	10	200	Confidence Level(95.0%)	62.78794975
SV16-10	10	170		
SV17-8	8	130		
SV18-10	10	370		
SV19-10	<u>10</u>	220		
Average		9		

Benzene Soil Gas Shallow 9ft  
95% Confidence Conc = 280  $\mu\text{g/m}^3$   
Residential

DATA ENTRY SHEET

SG-SCREEN  
DA Version 2.0; 04/

Reset to  
Defaults

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Soil Gas Concentration Data			
ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., $C_g$ ( $\mu\text{g/m}^3$ )	OR	ENTER Soil gas conc., $C_g$ (ppmv)
71432	2.80E+02		Benzene
Chemical			
<input type="button" value="ENTER"/> Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)			
ENTER Soil gas sampling depth below grade, $L_s$ (cm) Average soil temperature, $T_s$ ( $^{\circ}\text{C}$ )			
ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)			
ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )			
ENTER Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)			
ENTER Vadose zone soil total porosity, $n_v$ (unitless)			
ENTER Vadose zone soil water-filled porosity, $\theta_w$ ( $\text{cm}^3/\text{cm}^3$ )			
ENTER Average vapor flow rate into bldg. (leave blank to calculate) $Q_{\text{sol}}$ ( $\text{L}/\text{m}$ )			
ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g}/\text{cm}^3$ )			
ENTER Averaging time for carcinogens, $A\bar{T}_c$ (yrs)			
ENTER Exposure duration, ED (yrs)			
ENTER Exposure frequency, EF (days/yr)			
END			

Benzene Soil Gas Shallow 9ft  
95% Confidence Concentration = 280 ug/m<sup>3</sup>  
Residential

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.5E-07	2.0E-03

MESSAGE SUMMARY BELOW:

# Benzene Soil Gas Deep

## MAX Conc 290 mg/L SV | 9-23

### Residential

#### DATA ENTRY SHEET

SG-SCREEN  
A Version 2.0; 04/

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Soil Gas Concentration Data			
<input type="button" value="ENTER"/>	Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )	<input type="button" value="ENTER"/>	Soil gas conc., $C_a$ (ppmv)
	71432	2.90E+02	<input type="button" value="Chemical"/>  Benzene
<input type="button" value="ENTER"/>	Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm)	<input type="button" value="ENTER"/>	Soil gas sampling depth below grade, $L_s$ (cm)
	15	700	19
<input type="button" value="MORE"/> 	Vadose zone SCS soil type <input type="button" value="Lookup Soil Parameters"/>	<input type="button" value="ENTER"/>	Vadose zone SCS soil type (used to estimate soil vapor permeability)
	SI	1.5	SI
<input type="button" value="MORE"/> 	Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g}/\text{cm}^3$ )	<input type="button" value="ENTER"/>	Vadose zone soil total porosity, $n^V$ (unitsless)
	SI	1.5	0.43
<input type="button" value="MORE"/> 	Averaging time for carcinogens, $A_{TC}$ (yrs)	<input type="button" value="ENTER"/>	Averaging time for noncarcinogens, $A_{TNC}$ (yrs)
	70	30	30
			350

<input type="button" value="ENTER"/>	User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	<input type="button" value="ENTER"/>	Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ ( $\text{L}/\text{m}$ )
	SI	0.15	

## RESULTS SHEET

### INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
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5.3E-07	1.4E-03
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MESSAGE SUMMARY BELOW:

END

# Benzene Groundwater Residential

**GW-SCREEN**  
Version 3.0; 04/03

**Reset to  
Defaults**

## DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)		DTSC Vapor Intrusion Guidance Interim Final 12/04 (last modified 2/4/09)
<input type="checkbox"/> YES	<input type="checkbox"/>	OR
CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)		

YES       X

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., $C_w$ ( $\mu\text{g/L}$ )	ENTER Chemical
71432	1.30E+00	Benzene

ENTER Depth below grade to bottom of enclosed space floor, $L_f$ (cm)	ENTER Depth below grade to water table, $L_{WT}$ (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/ groundwater temperature, $T_s$ (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m)
15	1200	SI	19	

**MORE** ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, $k_v$ (cm <sup>-2</sup> )	ENTER Vadose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, $P_b^v$ (g/cm <sup>3</sup> )	ENTER Vadose zone soil total porosity, $n^v$ (unitless)	ENTER Vadose zone soil water-filled porosity, $\theta_w^v$ (cm <sup>3</sup> /cm <sup>3</sup> )
SI				1.5	0.15

**MORE** ↓

ENTER Target hazard quotient for carcinogens, TR (unitless)	ENTER Averaging time for noncarcinogens, AT <sub>c</sub> (years)	ENTER Averaging time for noncarcinogens, AT <sub>nc</sub> (years)	ENTER Exposure duration, ED (years)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	350

Used to calculate risk-based  
groundwater concentration.

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

*Residential*

## RESULTS SHEET

## RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

## INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc.,	Pure component water solubility, S ( $\mu\text{g/L}$ )	Final indoor exposure groundwater conc.,	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	1.79E+06	NA	8.3E-08

MESSAGE SUMMARY BELOW:

## **ATTACHMENT B**

TCE SOIL VAPOR AND GROUNDWATER RISK AND HAZARD  
SCREENING TCE 95% UPPER CONFIDENCE CONCENTRATION  
DETERMINATIONS

**SG-SCREEN**  
PA Version 2.0; 04/

**Reset to  
Defaults**

TC-C Join and Sweep

Max Conc 73,000 mg/m<sup>3</sup> SVL6-24

Commercial

**DATA ENTRY SHEET**

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

<b>ENTER</b>	Chemical CAS No. (numbers only, no dashes)	<b>ENTER</b> Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )	<b>ENTER</b> Soil gas conc., $C_g$ (ppmv)	<b>ENTER</b> Soil gas conc., $C_g$ (ppmv)
	79016	7.30E+04		

<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)	<b>ENTER</b> Soil gas sampling depth below grade, $L_s$ (cm)	<b>ENTER</b> Average soil temperature, $T_s$ (°C)	<b>ENTER</b> Vadose zone SCS soil type (used to estimate soil vapor permeability)	<b>ENTER</b> User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )
	15	730	19	SI

<b>ENTER</b> Vadose zone SCS soil type	<b>ENTER</b> Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g}/\text{cm}^3$ )	<b>ENTER</b> Vadose zone soil total porosity, $n^v$ (unitless)	<b>ENTER</b> Vadose zone soil water-filled porosity, $\theta_w$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{\text{soil}}$ ( $\text{L}/\text{m}$ )
SI	1.5	0.43	0.15	

<b>ENTER</b> Averaging time for carcinogens, $A T_c$ (yrs)	<b>ENTER</b> noncarcinogens, $A T_{nc}$ (yrs)	<b>ENTER</b> Exposure duration, ED (yrs)	<b>ENTER</b> Exposure frequency, EF (days/yr)
70	25	25	105

**END**

TCI Soil Gas Deep  
max conc 3,000  $\mu\text{g/m}^3$  SV16-24  
Commercial

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.1E-06	4.9E-03

MESSAGE SUMMARY BELOW:

**TABLE B1. TCE DEEP SOIL GAS  
95% CONFIDENCE CONCENTRATION DETERMINATION**

Sample ID	Sample Depth (ft)	TCE Concentration (ug/M3)	<i>EXCEL Statistical Analysis</i>	
SV1-23	23	2700		
SV2-23	23	100	Mean	5894.736842
SV3-23	23	180	Standard Error	3868.215991
SV4-23	23	100	Median	100
SV5-23	23	100	Mode	100
SV6-23	23	100	Standard Deviation	16861.1626
SV7-23	23	100	Sample Variance	284298804.1
SV8-23	23	100	Kurtosis	15.92507571
SV9-25	25	100	Skewness	3.895405305
SV10-23	23	100	Range	72900
SV11-25	25	370	Minimum	100
SV12-23	23	110	Maximum	73000
SV13-23	23	100	Sum	112000
SV14-23	23	12000	Count	19
SV15-23	23	240	Confidence Level(95.0%)	8126.820219
SV16-24	24	73000		
SV17-23	23	16000		
SV18-25	25	100		
SV19-23	<u>23</u>	6400		
Average	24			

# TCE Soil Gas Deep 2.3 ft

SG-SCREEN  
PA Version 2.0; 04/

**Reset to  
Defaults**

## DATA ENTRY SHEET

95% Conf. Conc = 14,000  $\mu\text{g}/\text{m}^3$

Residential

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Soil Gas Concentration Data	
<b>ENTER</b> Chemical CAS No. (numbers only, no dashes)	<input type="text"/> Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )  <input type="text"/> 78016      1.40E+04
<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)	<input type="text"/> Soil gas sampling depth below grade, $L_s$ (cm)  <input type="text"/> 15      700
<b>MORE</b> ↓	<input type="text"/> Vadose zone SCS Soil type  <input type="text"/> 1.5

Soil Gas Concentration Data	
<b>ENTER</b> Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )	<input type="text"/> Soil gas conc., $C_g$ (ppmv)  <input type="text"/> Trichloroethylene
<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)	<input type="text"/> Average soil temperature, $T_s$ (°C)  <input type="text"/> 15      700
<b>MORE</b> ↓	<input type="text"/> Vadose zone SCS Soil type  <input type="text"/> 1.5

Soil Gas Concentration Data	
<b>ENTER</b> Soil gas conc., $C_g$ (ppmv)	<input type="text"/> Soil gas conc., $C_g$ (ppmv)  <input type="text"/> Trichloroethylene
<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)	<input type="text"/> Average soil temperature, $T_s$ (°C)  <input type="text"/> 15      700
<b>MORE</b> ↓	<input type="text"/> Vadose zone SCS Soil type  <input type="text"/> 1.5

Soil Gas Concentration Data	
<b>ENTER</b> Soil gas conc., $C_g$ (ppmv)	<input type="text"/> Soil gas conc., $C_g$ (ppmv)  <input type="text"/> Trichloroethylene
<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (15 or 200 cm)	<input type="text"/> Average soil temperature, $T_s$ (°C)  <input type="text"/> 15      700
<b>MORE</b> ↓	<input type="text"/> Vadose zone SCS Soil type  <input type="text"/> 1.5

**END**

TCE Soil Gas Deep 23 ft  
95% Conf Conc = 14,000  $\mu\text{g}/\text{m}^3$

## Residential

### RESULTS SHEET

#### INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.6E-06	3.2E-03

MESSAGE SUMMARY BELOW:

**END**

TCE Soil Gas Deep 23'  
 95% Conf Conc = 14,000  $\mu\text{g/m}^3$   
 Commercial 105 days

DATA ENTRY SHEET

SG-SCREEN  
A Version 2.0; 04/

Reset to  
Defaults

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Soil Gas Concentration Data		ENTER	
ENTER Chemical CAS No. (numbers only, no dashes)	Soil gas conc., $C_g$ ( $\mu\text{g/m}^3$ )	OR	Soil gas conc., $C_g$ (ppmv)
79016	1.40E+04		Trichloroethylene
ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm)		ENTER Soil gas sampling depth below grade, $L_s$ (cm)	Vadose zone SCS soil type (used to estimate soil vapor permeability)
15		700	19
		SI	
ENTER MORE ↓ Vadose zone SCS soil type Lookup Soil Parameters		ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g/cm}^3$ )	Vadose zone soil total porosity, $n^V$ (unitless)
		SI	0.43
		SI	0.15
ENTER MORE ↓ Averaging time for carcinogens, $A\bar{T}_c$ (yrs)		ENTER Averaging time for noncarcinogens, $A\bar{T}_{NC}$ (yrs)	Exposure duration, ED (yrs)
70		25	26
		105	
END			

ENTER  
User-defined  
vadose zone  
soil vapor  
permeability,  
 $k_v$   
( $\text{cm}^2$ )

ENTER  
Average vapor  
flow rate into bldg.  
(Leave blank to calculate)  
 $Q_{\text{soil}}$   
( $\text{L/m}$ )

ENTER  
Vadose zone  
soil water-filled  
porosity,  
 $\theta_w^V$   
( $\text{cm}^3/\text{cm}^3$ )

ENTER  
Vadose zone  
soil total  
porosity,  
 $n^V$   
(unitless)

ENTER  
Exposure  
frequency,  
EF  
(days/yr)

ENTER  
Exposure  
duration,  
ED  
(yrs)

ICE Soil Gas Deep 23  
95% Conf. Conc = 14,000  $\mu\text{g}/\text{m}^3$   
Commercial 105 days

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
4.3E-07	1.0E-03

MESSAGE SUMMARY BELOW:

# TCE Groundwater residential

max conc 4600  $\mu\text{g}/\text{L}$

## DATA ENTRY SHEET

**GW-SCREEN**  
Version 3.0; 04/03

**Reset to  
Defaults**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION  
(enter "X" in "YES" box and initial groundwater conc. below)

YES

ENTER Initial groundwater conc.,  
Chemical CAS No.  
(numbers only,  
no dashes)

$C_w$   
( $\mu\text{g}/\text{L}$ )

Chemical

79016  4.60E+03  Trichloroethylene

ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm)	ENTER Depth below grade to water table, $L_{WT}$ (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, $T_s$ ( $^{\circ}\text{C}$ )	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ ( $\text{L}/\text{m}$ )
15	1300	SI	19	

**MORE**

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, $\rho_b^v$ ( $\text{g}/\text{cm}^3$ )	ENTER Vadose zone soil porosity, $n^v$ (unitless)
SI				1.5

**MORE**

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, $\rho_b^v$ ( $\text{g}/\text{cm}^3$ )	ENTER Vadose zone soil porosity, $n^v$ (unitless)
SI				0.43

**MORE**

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT <sub>C</sub> (yrs)	ENTER Averaging time for noncarcinogens, AT <sub>NC</sub> (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	30	350

Used to calculate risk-based groundwater concentration.

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

DTSC Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

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9/2/2011  
9:43 AM

TCE Groundwater  
residential  
Max Conc 4,600 µg/L

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Pure component water solubility, S ( $\text{mg/L}$ )	Final indoor exposure groundwater conc., ( $\mu\text{g/L}$ )	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	1.47E+06	NA	3.3E-05

MESSAGE SUMMARY BELOW:

**END**

# TCE Groundwater

Commercial (105 days/yr)  
MAX CONC 4,600 ug/l

## DATA ENTRY SHEET

**GW-SCREEN**  
Version 3.0; 04/03

Reset to  
Defaults

YES   
OR

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

YES

ENTER

Initial  
groundwater  
conc.,  
 $C_w$   
( $\mu\text{g/L}$ )

Chemical

CAS No.  
(numbers only,  
no dashes)

79016	4.60E+03	Trichloroethylene
-------	----------	-------------------

ENTER Depth  
below grade  
to bottom  
of enclosed  
space floor,  
 $L_f$   
(cm)

Depth below grade to water table, $L_{wr}$ (cm)	SCS soil type directly above water table	Average soil/ groundwater temperature, $T_s$ (°C)	Average vapor flow rate into bldg. (Leave blank to calculate)
---	---	--	---

15	1300	SI	19
----	------	----	----

**MORE**  
↓

ENTER  
Vadose zone  
SCS  
soil type  
(used to estimate  
soil vapor  
permeability)

SI	User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	Vadose zone SCS soil type Lookup Soil Parameters	Vadose zone soil dry bulk density, $\rho_b$ ( $\text{g/cm}^3$ )	Vadose zone soil total porosity, $n_v$ (unitless)	Vadose zone soil water-filled porosity, $\theta_w^v$ ( $\text{cm}^3/\text{cm}^3$ )
----	--	--	---	---	--

**MORE**  
↓

ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	ENTER Vadose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, $\rho_b$ ( $\text{g/cm}^3$ )	ENTER Vadose zone soil total porosity, $n_v$ (unitless)	ENTER Vadose zone soil water-filled porosity, $\theta_w^v$ ( $\text{cm}^3/\text{cm}^3$ )
			1.5	0.43
				0.15

**MORE**  
↓

ENTER Target risk for  
carcinogens,  
 $TR$   
(unitless)

ENTER Target hazard  
quotient for  
noncarcinogens,  
 $THQ$   
(unitless)

1.0E-06	1	70	25	25	105
---------	---	----	----	----	-----

Used to calculate risk-based  
groundwater concentration.

DTSC / HERD  
Last Update: 11/1/03

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

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9/2/2011  
9:35 AM

## RESULTS SHEET

## RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Pure component water solubility, S ( $\mu\text{g/L}$ )	Final indoor exposure groundwater conc., conc., ( $\mu\text{g/L}$ )	NA
NA	NA	NA	NA	1.47E+06	NA

MESSAGE SUMMARY BELOW:

**END**

1CE Groundwater  
Commercial (105 days/yr)  
Max Conc 4,600 ug/l

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Pure component water solubility, S ( $\mu\text{g/L}$ )	Final indoor exposure groundwater conc., conc., ( $\mu\text{g/L}$ )	NA	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	1.47E+06	NA	8.2E-06	1.9E-02

**TABLE B2. TCE GROUNDWATER  
95% CONFIDENCE CONCENTRATION DETERMINATION**

Sample ID	Sample Depth (ft)	TCE Concentration (ug/l)	<i>EXCEL Statistic Analysis</i>	
MW-3	39	0.5		
SV1-42	42	4600	Mean	1264.40625
			Standard Error	294.4226668
SV2-46	46	2300	Median	1050
			Mode	2300
SV3-46	46	1800	Standard Deviation	1177.690667
			Sample Variance	1386955.307
SV4-46	46	1700	Kurtosis	3.270350246
			Skewness	1.505985106
SV6-46	46	2300	Range	4599.5
			Minimum	0.5
SV7-51.5	51.5	1800	Maximum	4600
			Sum	20230.5
SV9-46	46	120	Count	16
			Confidence Level(95.0%)	627.5470564
SV10-46	46	220		
SV11-46	46	220	95% Confidence Concentration =	
			1300 + 630 = 1900 ug/l	
SV12-46	46	1100		
SV14-46	46	1100		
SV15-46	46	950		
SV16-46	46	910		
SV17-46	46	1000		
SV19-50	<u>50</u>	110		
Average	46			

11/1/2011 Conf conc = 1900 µg/L  
Residential

### DATA ENTRY SHEET

**GW-SCREEN**  
Version 3.0; 04/03

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION  
(enter "X" in "YES" box and initial groundwater conc. below)

YES  X

ENTER Initial groundwater conc.,  
C<sub>w</sub> (µg/L)

Chemical

79016	1.90E+03	Trichloroethylene
-------	----------	-------------------

ENTER Depth below grade to bottom of enclosed space floor, L <sub>f</sub> (cm)	ENTER Depth below grade to water table, L <sub>wrt</sub> (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, T <sub>s</sub> (°C)	ENTER Average vapor flow rate into bidg. (Leave blank to calculate) Q <sub>soil</sub> (L/m)
15	1400	Si	19	

**MORE** ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, k <sub>v</sub> (cm <sup>2</sup> )	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ <sub>b</sub> (g/cm <sup>3</sup> )	ENTER Vadose zone soil total porosity, n <sup>v</sup>
Si		Lookup Soil Parameters		(unitless)

**MORE** ↓

ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, A <sub>T<sub>c</sub></sub> (yrs)	ENTER Averaging time for noncarcinogens, A <sub>T<sub>NC</sub></sub> (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	30	350

Used to calculate risk-based groundwater concentration.

TCE Groundwater  
95% Conf Conc = 1900 µg/L  
Residential

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	1.47E+06	NA	1.3E-05

MESSAGE SUMMARY BELOW:

**END**

**GW-SCREEN**  
Version 3.0; 04/03

Reset to  
Defaults

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION  
(enter "X" in "YES" box and initial groundwater conc. below)

YES

ENTER  
Initial  
groundwater  
conc.,  
 $C_w$   
( $\mu\text{g/L}$ )

Chemical

79016	1.90E+03	Trichloroethylene
-------	----------	-------------------

ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm)	ENTER Depth below grade to water table, $L_{wr}$ (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/water temperature, $T_s$ (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{soil}$ (L/m)
15	1400	SI	19	

**MORE**  
↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	ENTER Vadose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, $\rho_b^v$ ( $\text{g/cm}^3$ )	ENTER Vadose zone soil total porosity, $n^v$ (unitless)
SI				1.5
				0.43
				0.15

**MORE**  
↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	ENTER Vadose zone SCS soil type Lookup Soil Parameters	ENTER Vadose zone soil dry bulk density, $\rho_b^v$ ( $\text{g/cm}^3$ )	ENTER Vadose zone soil water-filled porosity, $\theta_w^v$ ( $\text{cm}^3/\text{cm}^3$ )
SI				

**MORE**  
↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, $AT_c$ (yrs)	ENTER Averaging time for noncarcinogens, $AT_{nc}$ (yrs)	ENTER Exposure duration, ED (yrs)
1.0E-06	1	70	25	25
				105

Used to calculate risk-based  
groundwater concentration.

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Commercial (105 days/yr)  
95% Conf Conc = 1900  $\mu\text{g/L}$

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9/6/2011  
10:50 AM

## RESULTS SHEET

## RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g}/\text{L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g}/\text{L}$ )	Risk-based indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g}/\text{L}$ )	Pure component water solubility, S ( $\mu\text{g}/\text{L}$ )	Final indoor exposure groundwater conc., (NA)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	1.47E+06	NA	9.8E-07

MESSAGE SUMMARY BELOW:

END

INCIDENTAL RISK CALCULATIONS: 95% Conf conc = 1900  $\mu\text{g}/\text{L}$ '11 USE Groundwater  
Commercial 105 days/yr

## **ATTACHMENT C**

PCE SOIL VAPOR AND GROUNDWATER RISK AND HAZARD  
SCREENING PCE 95% UPPER CONFIDENCE CONCENTRATION  
DETERMINATION

**SG-SCREEN**  
A Version 2.0; 04/

**Reset to  
Defaults**

Soil Gas Concentration Data	
ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ ) OR ENTER Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )
127184	3.00E+02

**MORE ↓** ENTER Depth below grade to bottom of enclosed space floor,  $L_f$  (15 or 200 cm)

ENTER Soil sampling depth below grade, $L_s$ (cm)	ENTER Average soil temperature, $T_s$ (°C)	ENTER Vadose zone SCS Soil type (used to estimate soil vapor permeability)
15	310	19

**Si**

ENTER Vadose zone SCS Soil type Lockup Soil Parameters	ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g}/\text{cm}^3$ )	ENTER Vadose zone soil total porosity, $n_v$ (unitless)	ENTER Vadose zone soil water-filled porosity, $\theta_w^v$ ( $\text{cm}^3/\text{cm}^3$ )
Si	1.5	0.43	0.15

ENTER Vadose zone SCS Soil type Lockup Soil Parameters	ENTER Averaging time for carcinogens, $AT_c$ (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
70	30	30	350

**MORE ↓**

**END**

**DATA ENTRY SHEET**

**DTSC**  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

*Max conc 300 ug/L SVg-10  
residential*

**ENTER**

User-defined  
vadose zone  
soil vapor  
permeability,  
 $k_v$   
( $\text{cm}^3/\text{s}$ )

**OR**

Average vapor  
flow rate into bldg.  
(leave blank to calculate)  
 $Q_{\text{Soil}}$   
( $\text{L}/\text{m}$ )

**ENTER**

Average vapor  
flow rate into bldg.  
(leave blank to calculate)  
 $Q_{\text{Soil}}$   
( $\text{L}/\text{m}$ )

**ENTER**

Average vapor  
flow rate into bldg.  
(leave blank to calculate)  
 $Q_{\text{Soil}}$   
( $\text{L}/\text{m}$ )

ENTER Vadose zone SCS Soil type Lockup Soil Parameters	ENTER Averaging time for carcinogens, $AT_c$ (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
70	30	30	350

PCE Soil Gas Shallow  
max conc. 300  $\mu\text{g}/\text{L}$  SV<sup>g-1c</sup>  
residential

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.4E-07	1.6E-03

MESSAGE SUMMARY BELOW:

PC: Son was wcep  
MAX CONC 2400 ug/m<sup>3</sup> SV16-24  
residential

SG-SCREEN  
A Version 2.0; 04]

Soil Gas Concentration Data					
ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ ) OR ENTER Soil gas conc., $C_g$ ( $\mu\text{g}/\text{m}^3$ )	ENTER Soil gas conc., $C_g$ (ppmv)	ENTER Soil gas conc., $C_g$ (ppmv)	Chemical Tetrachloroethylene	
	127184	2.40E+03			
<input type="button" value="MORE ↓"/>	ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (15 or 200 cm)	ENTER Soil gas sampling depth below grade, $L_s$ (cm)	ENTER Average soil temperature, $T_s$ (°C)	ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER User-defined vadose zone soil vapor permeability, $k_v$ ( $\text{cm}^2$ )
	15	730	19	SI	
<input type="button" value="MORE ↓"/>	ENTER Vadose zone SCS soil type Lockup Soil Parameters	ENTER Vadose zone soil dry bulk density, $\rho_b^A$ ( $\text{g}/\text{cm}^3$ )	ENTER Vadose zone soil total porosity, $\eta^V$ (unitless)	ENTER Vadose zone soil water-filled porosity, $\theta_w^V$ ( $\text{cm}^3/\text{cm}^3$ )	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) $Q_{\text{gall}}$ ( $\text{L}/\text{m}$ )
	SI	1.5	0.43	0.15	
<input type="button" value="MORE ↓"/>	ENTER Averaging time for carcinogens, $AT_c$ (yrs)	ENTER noncarcinogens, $AT_nc$ (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)	
	70	30	30	350	

#### DATA ENTRY SHEET

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

PCE Soil Gas Deep  
MAX CONC 2,400  $\mu\text{g/m}^3$  SV16-24  
residential

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.7E-07	8.7E-03

MESSAGE SUMMARY BELOW:

# Print Groundwater Residential

**DATA ENTRY SHEET**

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04

(last modified 2/4/09)

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION  
(enter "X" in "YES" box and initial groundwater conc. below)

YES

OR

YES

ENTER Initial groundwater conc.,  
Chemical  
CAS No.  
(numbers only,  
no dashes)

Chemical

127184  1.20E+02  Tetrachloroethylene

ENTER Depth below grade to bottom of enclosed space floor, L<sub>f</sub> (cm)

ENTER Depth below grade to water table, L <sub>WT</sub> (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, T <sub>s</sub> (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate) Q <sub>soil</sub> (L/m)
15	1200	SI	19

**MORE** 

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)

OR

SI

ENTER Vadose zone SCS soil type	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ <sub>b</sub> <sup>v</sup> (g/cm <sup>3</sup> )	ENTER Vadose zone soil total porosity, n <sup>v</sup> (unitless)	ENTER Vadose zone soil water-filled porosity, θ <sub>w</sub> <sup>v</sup> (cm <sup>3</sup> /cm <sup>3</sup> )
Lookup Soil Parameters				
			1.5	0.43
				0.15

**MORE** 

ENTER User-defined vadose zone soil vapor permeability, k<sub>v</sub> (cm<sup>2</sup>)

SI

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT <sub>c</sub> (yrs)	ENTER Averaging time for noncarcinogens, AT <sub>NC</sub> (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
Used to calculate risk-based groundwater concentration.					
1.0E-06	1	70	30	30	350

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

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9/2/2011  
9:16 AM

**GW-SCREEN**  
Version 3.0; 04/03

**Reset to Defaults**

## RESULTS SHEET

**PCE Residential  
Groundwater**  
~~max conc 120 µg/L~~

## RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

## INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen (µg/L)	Indoor exposure groundwater conc., noncarcinogen (µg/L)	Risk-based indoor exposure groundwater conc., (µg/L)	Pure component water solubility, S (µg/L)	Final indoor exposure groundwater conc., (µg/L)	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	2.00E+05	NA	4.0E-06

MESSAGE SUMMARY BELOW:

**END**

PL - Groundwater  
 Commercial 105days/yr  
 10 hrs/day  
 MAX CONC 120 µg/L

DATA ENTRY SHEET	
CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)	
<input type="checkbox"/> YES	<input type="checkbox"/>
<b>OR</b>	
CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)	
<input type="checkbox"/> YES	<input type="checkbox"/> X

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<input type="button" value="Reset to Defaults"/>

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., $C_W$ (µg/L)	Chemical
<b>127184</b> <b>1.20E+02</b> <b>Tetrachloroethylene</b>		

ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm)	ENTER Depth below grade to water table, $L_WT$ (cm)	ENTER SCS soil type directly above water table	ENTER Average soil/groundwater temperature, $T_s$ (°C)	ENTER Average vapor flow rate into bldg. (Leave blank to calculate)
<b>15</b>	<b>1200</b>	<b>Si</b>	<b>19</b>	<b>Q_soil</b> (L/m)

**MORE** ↓

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER Vadose zone SCS soil type OR (used to estimate soil vapor permeability)	ENTER Vadose zone SCS soil type Lockup Soil Parameters
<b>Si</b>	<b>Si</b>	<b>Si</b>

ENTER User-defined vadose zone soil vapor permeability, $k_v$ (cm²)	ENTER Vadose zone soil dry bulk density, $\rho_b^v$ (g/cm³)	ENTER Vadose zone soil total porosity, $n^v$ (unitless)	ENTER Vadose zone soil water-filled porosity, $\theta_w^v$ (cm³/cm³)
<b>1.0E-06</b>	<b>1</b>	<b>0.43</b>	<b>0.15</b>

**MORE** ↓

ENTER Target hazard quotient for noncarcinogens, TR (unitless)	ENTER Averaging time for carcinogens, AT <sub>NC</sub> (yrs)	ENTER Noncarcinogen, AT <sub>NC</sub> (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
<b>1.0E-06</b>	<b>1</b>	<b>70</b>	<b>25</b>	<b>105</b>

Used to calculate risk-based groundwater concentration.	DTSC Indoor Air Guidance Unclassified Soil Screening Model
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# PCE Groundwater

Commercial (105 days/yr)  
10 hr/day  
max Q done 120 mg/L

## RESULTS SHEET

### RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

#### INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc.,	Pure water solubility, S ( $\mu\text{g/L}$ )	Final indoor exposure groundwater conc.,	Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	2.00E+05	NA	1.0E-06

MESSAGE SUMMARY BELOW:

**END**

**TABLE C1. PCE GROUNDWATER  
95% CONFIDENCE CONCENTRATION DETERMINATION**

Sample ID	Sample Depth (ft)	PCE Concentration (ug/l)	<i>EXCEL Statistic Analysis</i>	
MW-3	39	120		
SV1-42	42	100	Mean	49
SV2-46	46	66	Standard Error	7.182153809
SV3-46	46	31	Median	37.5
SV4-46	46	77	Mode	#N/A
SV6-46	46	50	Standard Deviation	28.72861524
SV7-51.5	51.5	47	Sample Variance	825.3333333
SV9-46	46	32	Kurtosis	1.394380599
SV10-46	46	27	Skewness	1.397282111
SV11-46	46	21	Range	100
SV12-46	46	38	Minimum	20
SV14-46	46	35	Maximum	120
SV15-46	46	28	Sum	784
SV16-46	46	20	Count	16
SV17-46	46	55	Confidence Level(95.0%)	15.3083984
SV19-50	<u>50</u>	37		
Average		46	95% Confidence Concentration = $49 + 15 = 64 \text{ ug/l}$	

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**Reset to  
Details**

DATA ENTRY SHEET

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES

OR

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION  
(enter "X" in "YES" box and initial groundwater conc. below)

YES

X

ENTER Initial groundwater conc., C<sub>w</sub> (ug/L)

Chemical CAS No. (numbers only, no dashes)

ENTER Depth below grade to bottom of enclosed space floor, L<sub>f</sub> (cm)

ENTER Depth below grade to water table, L<sub>wrt</sub> (cm)

ENTER SCS soil type directly above water table

Average soil/groundwater temperature, T<sub>s</sub> (°C)

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)

ENTER User-defined vadose zone soil vapor permeability, k<sub>v</sub> (cm<sup>2</sup>)

ENTER Target hazard quotient for noncarcinogens, THQ (unitless)

ENTER Target risk for carcinogens, TR (unitless)

ENTER Averaging time for carcinogens, AT<sub>c</sub> (years)

ENTER Averaging time for noncarcinogens, AT<sub>NC</sub> (years)

ENTER Exposure duration, ED (years)

ENTER Exposure frequency, EF (days/yr)

ENTER Vadose zone soil dry bulk density, ρ<sub>b</sub><sup>v</sup> (g/cm<sup>3</sup>)

ENTER Vadose zone soil total porosity, n<sup>v</sup> (unitless)

ENTER Vadose zone soil water-filled porosity, θ<sub>w</sub><sup>v</sup> (cm<sup>3</sup>/cm<sup>3</sup>)

ENTER Exposure frequency, EF (days/yr)

Used to calculate risk-based groundwater concentration.

DTSC Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

Copy of HERD\_Groundwater\_Screening\_Model\_2009rev.xls  
9/6/2011  
10:58 AM

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

DTSC / HERD  
Last Update: 11/1/03

Fus Gravidae  
95% Conf Conc = 64 µg/L

## RESULTS SHEET

### RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

### INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Pure component water solubility, S ( $\mu\text{g/L}$ )	Final indoor exposure groundwater conc., ( $\mu\text{g/L}$ )	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	NA	NA	NA	2.00E+05	NA

MESSAGE SUMMARY BELOW:

**END**

PCE Groundwater  
Commercial (105 days/yr)  
95% Confid. Conc.: 64  $\mu$ g/L

DATA ENTRY SHEET	
CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)	
<input type="checkbox"/>	YES
<input type="checkbox"/> OR	
CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)	
<input type="checkbox"/>	X

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Reset to  
Defaults

DTSC  
Vapor Intrusion Guidance  
Interim Final 12/04  
(last modified 2/4/09)

ENTER Initial groundwater conc., C<sub>w</sub>, ( $\mu$ g/L)

Chemical

127184

6.40E+01

Tetrachloroethylene

ENTER Depth below grade to bottom of enclosed space floor, L<sub>F</sub> (cm)

ENTER Depth below grade to water table, L<sub>WT</sub> (cm)

SCS soil type directly above water table

T<sub>s</sub> (°C)

ENTER Average vapor ground temperature, T<sub>s</sub> (°C)

Q<sub>soil</sub>

(L/m)

ENTER Vadose zone SCS soil type (used to estimate soil vapor permeability)	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ <sub>b</sub> <sup>v</sup> (g/cm <sup>3</sup> )	ENTER Vadose zone soil total porosity, n <sup>v</sup> (unitless)	ENTER Vadose zone soil water-filled porosity, θ <sub>w</sub> <sup>v</sup> (cm <sup>3</sup> /cm <sup>3</sup> )
SI	SI	1.5	1.5	0.15

MORE ↓

ENTER User-defined vadose zone soil vapor permeability, k <sub>v</sub> (cm <sup>2</sup> )	ENTER Vadose zone SCS soil type	ENTER Vadose zone soil dry bulk density, ρ <sub>b</sub> <sup>v</sup> (g/cm <sup>3</sup> )	ENTER Vadose zone soil total porosity, n <sup>v</sup> (unitless)	ENTER Vadose zone soil water-filled porosity, θ <sub>w</sub> <sup>v</sup> (cm <sup>3</sup> /cm <sup>3</sup> )
SI	SI	1.5	1.5	0.15

MORE ↓

ENTER Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)	ENTER Averaging time for carcinogens, AT <sub>NC</sub> (yrs)	ENTER Averaging time for noncarcinogens, AT <sub>NC</sub> (yrs)	ENTER Exposure duration, ED (yrs)	ENTER Exposure frequency, EF (days/yr)
1.0E-06	1	70	25	25	105

Used to calculate risk-based groundwater concentration.

DTSC Indoor Air Guidance  
Unclassified Soil Screening Model

1.E-01 annual rate  
Commercial 105 day/yr  
95% Conf Conc = 64  $\mu\text{g/L}$

## RESULTS SHEET

### RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

INCREMENTAL RISK CALCULATIONS:

Indoor exposure groundwater conc., carcinogen ( $\mu\text{g/L}$ )	Indoor exposure groundwater conc., noncarcinogen ( $\mu\text{g/L}$ )	Risk-based indoor exposure groundwater conc.,	Pure component water solubility, S	Final indoor exposure groundwater conc., (µg/L)	Hazard quotient from vapor intrusion to indoor air, carcinogen (unitless)
NA	NA	NA	2.00E+05	NA	5.2E-07

MESSAGE SUMMARY BELOW:

**END**